



## Early Journal Content on JSTOR, Free to Anyone in the World

This article is one of nearly 500,000 scholarly works digitized and made freely available to everyone in the world by JSTOR.

Known as the Early Journal Content, this set of works include research articles, news, letters, and other writings published in more than 200 of the oldest leading academic journals. The works date from the mid-seventeenth to the early twentieth centuries.

We encourage people to read and share the Early Journal Content openly and to tell others that this resource exists. People may post this content online or redistribute in any way for non-commercial purposes.

Read more about Early Journal Content at <http://about.jstor.org/participate-jstor/individuals/early-journal-content>.

JSTOR is a digital library of academic journals, books, and primary source objects. JSTOR helps people discover, use, and build upon a wide range of content through a powerful research and teaching platform, and preserves this content for future generations. JSTOR is part of ITHAKA, a not-for-profit organization that also includes Ithaka S+R and Portico. For more information about JSTOR, please contact [support@jstor.org](mailto:support@jstor.org).

# The Petroleum Resources of the World\*

By DAVID WHITE

United States Geological Survey

## INTRODUCTION

**P**ETROLEUM in the United States is a wasting asset so far depleted as no longer to afford a secure foundation for the obligations based upon its assumed continued adequacy. Barring unexpected good fortune in the search for new supplies, or even less unexpected curtailment of consumption, the petroleum production of the United States is likely not only never again wholly to meet our requirements but even to start soon on the long decline of a waning output.

For the first time in her history the United States is witnessing the day when one of her greatest stores of mineral wealth—her most dazzling and spectacular endowment, on which her prosperity, industries, and standards of living are so largely dependent, and which imparts a characteristic and essential quality to her civilization—is approaching exhaustion and so is no longer able to meet her growing necessities. After sixty years of prodigal generosity and profligate waste she discovers that her oil heritage is far spent and that henceforth she must become more and more dependent on the stores of other countries. The purpose of this article is to review our domestic supplies and to consider their life and the extent to which they may supply our prospective needs; to present a rough attempt at an appraisal of the oil resources of other regions of the

world based on our present most insufficient and fragmentary knowledge, and to call attention to the necessity for assuring the protection of this country by securing, even under increasingly unfavorable competitive conditions, sufficient oil reserves abroad to provide for our needs as long as oil is available to meet the requirements of other nations.

## OIL FIELDS OF THE UNITED STATES

### *Oil Remaining Available in the Ground*

The quantity of oil remaining available in the ground in the United States in January, 1919, was conservatively estimated by the oil and gas geologists of the United States Geological Survey at 6,740,000,000 barrels.<sup>1</sup> By “available” is meant recoverable by present methods of production. About one-half of these reserves are heavy oils.

A word should be offered as to the basis of this estimate, its mode of preparation, and its probable range of error. It is based on the results of the personal examinations of many of the producing and possible oil regions of the United States by the different geologists; on reviews of the production histories of the discovered or developed fields in this and other countries; on the geological conditions of occurrence of oil fields in all parts of the world and comparison

<sup>1</sup> White, David, “Unmined Supply of Petroleum in the United States,” *Jour. Society of Automotive Engrs.*, Vol. 12, No. 5, 1919, pp. 361-363. Estimates for the various regions are given on p. 362.

\* Published by permission of the Director of the United States Geological Survey.

of these oil fields with geologically similar but untested regions in United States; on the study of the structure, composition, alteration, sequence, and relations of the geologic formations, and on the critical review of surface indications, well records, sections, well production curves, sand characters, water relations, etc. It represents, for the most part, the weighted best, but deliberately conservative judgments of these geologists in conferential consideration of all the data then available. It does not differ greatly from the results of two previous estimates made by geologists of the Survey, and it is probably the best founded and most reliable estimate yet formulated. Nevertheless, it is of necessity highly speculative, for, as every geologist knows, an estimate of a commodity so intangible and fickle as oil in the ground, especially in undeveloped and untested regions, is, at best, one in which many of the elements are merely scientifically calculated guesses in the formulation of which all lines of evidence are taken into account and weighed with the experience and judgment acquired in other regions. However, conceding that for many areas in the country the information is very fragmentary and inadequate, that there are many factors controlling the distribution of petroleum that are not yet understood by geologists, and that consequently such an estimate must necessarily be wildly speculative and subject to great latitude of error, it may nevertheless be argued that the progress of geologic examinations of the country and of exploration by the drill has gone so far, the principal factors of oil control are sufficiently proven, and the results of development are now so voluminous

that it is highly improbable that the error is more than 50 per cent. An error of 75 per cent seems so improbable as not to justify serious consideration at present.

On the basis of an estimated 6,740,000,000 barrels available in the ground in January, 1919, there should now (February, 1920) remain, in round numbers, 6,325,000,000 barrels. However, as stated, this estimate was published as distinctly conservative, though mention of this fact has not been made by those quoting it. At the present moment it appears as unlikely that the amount of oil that will actually be recovered will fall under 6,000,000 barrels as that it will be found to be more than 8,000,000 barrels, or about 25 per cent in excess. Therefore, viewing 6,325,000,000 barrels as distinctly conservative, 7,000,000,000 barrels may be regarded as a moderate but not distinctly liberal estimate of the oil remaining available in the ground in the United States February, 1920.<sup>2</sup> The estimate is subject to revision as exploration, including both the investigations by the geologists and tests by the drill, goes forward, and it will be revised from time to time.

#### *Progress in Exhaustion of Domestic Deposits*

Oil is now being taken from the ground in the United States at a rate very closely approaching 400,000,000 barrels per annum. This is five times the rate in 1901 and twice that of 1909. At the close of 1919 approximately 4,986,300,000 (nearly 5,000,000,000)

<sup>2</sup> A more liberal estimate by my colleague, E. W. Shaw, is "8 or 10 billion barrels." Proc. Nat. Gas Assoc. America, Cleveland, May 20, 1919. *The Income and Expense of Natural Gas Production*, p. 6.

barrels of oil had been produced in this country, since the Drake well was drilled in 1859. This is about 43 per cent of the original recoverable contents as estimated. All this oil that has been mined in the United States in sixty years would be taken out in thirteen years at the present rate of production. Impressive as this fact may be, it is less alarming than the realization that the recoverable oil in this country, according to the conservative estimate, would probably be practically exhausted in seventeen years if the 1919 rate (nearly 380,000-000 barrels) of production could be maintained for so long, while a reserve of 7,000,000,000 barrels, the moderately liberal estimate, would disappear in eighteen and one-half years. If an improbable excess of 2,500,000,000 barrels over the estimated amount be present, this excess would be enough to sustain the present draught for six and one-half years additional.

What improvements will in the next ten years be made in the process of extraction of the oil from the ground, and what the effects may be in recovering the great amounts of oil not "available" or recoverable by present methods remains to be seen. It is most important that studious attention be given to the problem of the more complete extraction of the oil than is possible by the methods now in general use. The estimated available supply should be increased in this way to the maximum.

Fortunately, the oil cannot so soon be taken from the ground. Even unheard of prices for crude, and scourging of the ground far more severe than that now in progress cannot within the next generation disclose all the oil pools in the strata, and though devices for

more rapid extraction may be invented and applied, the fields yet to be discovered cannot be drained so rapidly. Oil pools will be found, finally by accident, long after the search has waned and even in the next century. These are some of the reasons why, as will further be explained, the production of natural petroleum in the United States must pass its peak at an early date—probably within five years and possibly within three years—though the long sagging production curve may be carried out beyond the century.

The curve of the domestic production of petroleum, as compiled from statistics furnished by G. B. Richardson, geologist in charge of statistics of petroleum in the United States Geological Survey, is given in figure 1. It shows that for the last eight years the annual increase in the petroleum production of the United States has averaged around 20,000,000 barrels. The greatest increase (nearly 25,000-000 barrels) in marketed production was in the war year, 1917. The actual production increase from 355,927,000 to nearly 378,000,000,<sup>3</sup> or about 22,000,-000 barrels in 1919, as indicated by Mr. Richardson's preliminary figures, was due mainly to the unprecedented advances in oil prices, which have been the cause of wildly speculative activity in the oil business throughout the country, and, in part, to the fortunately wide extent and the profuse initial productivity of the north-central Texas district.

In January, 1919, when discussing the probable trend of the production of

<sup>3</sup> It is expected by Mr. Richardson that the statistics of oil used in the field, and other items not yet reported will raise the total production for 1919 to about 380,000,000 barrels of 42 gallons.

petroleum in the United States.<sup>4</sup> I expressed the view that the output of oil in 1919 could only with great difficulty be made to increase abreast of the increase of consumption in 1919, and that possibly within three years, and very probably within seven years, the production of this country would pass its climax, notwithstanding the growing deficiency as compared with the needs of the country. The increase in the output for 1919 seems at first largely to controvert this conclusion or at least to put farther ahead the beginning of the decline. However, even its significance as indicating postponement of the evil day is likely to be overestimated. The trend of the production curve has been maintained and the output forced upward in 1919, mainly by a great increase of over 3,500 (14 per cent) in wells drilled as compared with 1918,<sup>5</sup> and an enormous influx of capital, notwithstanding great and inexcusable waste of the latter. The energy, funds and equipment applied to the winning of oil from the ground promise to be even greater in 1920, though many holders of stock in the hordes of misguided or fraudulent oil companies are doomed to disappointment. In view of the augmenting forces concentrated in the struggle and the considerable proven areas of very rich territory ready for drilling, it seems probable not only that the 1919 rate of petroleum production will be more than maintained in 1920, but that, under the favoring influence of high prices still advancing and the prospect

of a continued increase in consumption, the normal annual increase of 1919 will be exceeded. Besides responding to increased costs of production, the remarkable advances in crude oil prices are to be regarded as reflecting also both the deficiency in our domestic output and an apprehended difficulty in securing foreign oil in amounts sufficient to satisfy our growing requirements.

As north-central Texas (the so-called Ranger district) falls off in petroleum yield it is probable that the domestic output will receive support from the formerly withdrawn and other public oil lands in Wyoming and California which are at this moment being made available for leasing; the Gulf Coastal Plain will doubtless for a long time make contributions, with Louisiana giving immediate assistance, and the Mid-Continent region—the Osage for example—undoubtedly contains important undiscovered pools. With the decline of the Ranger district, oil companies will give attention to regions hitherto regarded as more or less unfavorable, and older oil states will be reëxamined. Oil will be found and developed in some of the regions of Wyoming, Utah, Colorado, Montana and Alaska, which are not now viewed very hopefully, and, probably, New Mexico, Washington, Oregon and some other possible states. Oil men are certain to return to find new production, probably in minor amounts, in Kentucky and will more thoroughly search Illinois, Indiana, Tennessee and the northern Appalachian region. Michigan will surely be further tested, with chances for some success, notwithstanding the thick mantle of drift which so nearly blankets the underly-

<sup>4</sup> *Journal, Association of American Automotive Engineers*, Vol. IV, No. 5, 1919, pp. 361-363. Printed in advance of meeting, February 4-6, 1919.

<sup>5</sup> *Oil and Gas Journal*, January 23, 1920, p. 50.



WORLD MAP OF DEVELOPED AND POTENTIAL OIL RESOURCES

PREPARED BY THE U. S. GEOLOGICAL SURVEY

1919

COMPILED BY EUGENE ST. SMITH



ing structure. Not only must regions formerly abandoned be subjected to a more drastic review with testing, and regions damaged by water treated by new methods, but also regions rejected without testing will be given the most scientific attention. The culls and discards must be tried out, so far as the prices of oil and the resultant proceeds of wildcatting permit. It is far from improbable that the time will come when, the oil companies being unwilling to assume the risks of drilling in portions of the country, the state or the federal government will in some emergency be asked to test with the drill the possibilities of these areas at public expense.

Meanwhile, as the production peaks of fields now are passed and the yields decline, new fields, either still larger or in greater numbers, must be discovered and thrown in to fill the cumulative void. Not only must the 1919 rate of production be sustained but also greater and still greater increases are demanded. To thus continue increasing the domestic oil production of the United States for any appreciable term of years now seems impossible, even under the present extraordinary price stimulus. Failure to secure adequate supplies from foreign fields at competitive prices, and consequent further advances of the prices for domestic crude oil would, of course, drive our output to a maximum limited by the reduction of consumption demands as costs become prohibitive. In such a case all predictions would of necessity be declared off. The development of such a situation should not, however, be permitted, and steps should be taken to assure the needed foreign supplies at all times.

The welfare of the country demands it.

On the whole, therefore, after a review of the domestic fields, in which it threatens to be more and more difficult and costly to sustain even the present production rate after the most promising regions now under development have passed their peaks, it appears highly probable that the United States will have passed its production peak within five years or very soon thereafter, and possibly within three. Nothing is more certain than that this country must at an early date lose its supremacy in the oil world and become more and more dependent on the oil resources of other lands, except in so far as the situation may be saved by the successful production of artificial petroleum by the distillation of oil shales.

#### *Oil from Oil Shales*

No discussion of the petroleum resources of this country can overlook the great potential importance of our extensive oil shale deposits as possible sources of oil. The oil shale deposits of the United States are a possible source of oil in amounts far greater than all the available natural petroleum of this hemisphere. They form an enduring asset, sufficient to sustain an enormous ultimate load for an indefinite period. However, at present they are assets of undetermined cash value and, at best, difficult and slow of conversion or liquidation, and they cannot yet be drawn on to carry the burden of our petroleum requirements.

Oil shales are interbedded, sedimentary strata, consisting more or less largely of fossil organic débris and the decomposition products of plants and animals, probably mainly aquatic.



When sufficiently free from clay, sand, or other mineral matter, the oil shale layers or beds present both physical and chemical features characteristic of cannel coals, to which they are genetically related and into which they grade. Like other members of the cannel group, these fossil organic deposits are characteristically high in hydrogen and when decomposed (distilled) by heat, they yield large proportions of volatile matter, much of which may be condensed as oils. The latter differ in composition and qualities according to the methods, temperatures, etc., of distillation, and, according to the process, it is probable that they will be made essentially to constitute artificial petroleum. Generally, and by ordinary, simple, dry distillation they are asphaltic but most of them will yield paraffin, and other waxes in considerable amounts, and all contain nitrogen which varies, however, very greatly in the shales from different regions and formations.

Oil shales, in deposits of considerable thickness and extent, are found in different parts of the United States, but generally the thick deposits yield but few gallons per ton, while the rich deposits, including the low-grade cannel coals, are extremely limited in extent. Enormous amounts, in many strata of great thickness and relatively large area, are found bedded like coal in the Green River (Eocene) formation of northwestern Colorado, northeastern Utah, and southwestern Wyoming, and in a formation probably Miocene in age in northern Nevada.<sup>6</sup>

<sup>6</sup> Winchester, D. E., "Oil Shale in Northwestern Colorado and Adjacent Areas," *United States Geological Survey Bulletin*, 641, pp. 139-198, 1917.

Experimental tests show that some of the purer beds of oil shale yield over 70 gallons per ton and certain parts of some of the beds are claimed to yield over two barrels per ton. D. E. Winchester, who has mapped many of the deposits for the United States Geological Survey, reports that in northwestern Colorado and northeastern Utah there is enough of this shale in beds three feet or more in thickness, and capable of yielding 22 gallons<sup>7</sup> or more of oil to the ton by distillation, to provide as much as 40 billion barrels of oil from which five billion barrels or more of gasoline should be extracted. Larger proportions of gasoline should be produced by the employment of proper methods. If the deposits of southwestern Wyoming and the small areas of rich shale in Nevada be added, the roughly estimated production mentioned above may be enormously increased—possibly doubled. Deposits of oil shale of limited extent, and generally less rich, are present in a number of states, namely, Pennsylvania, Indiana, Kentucky, Texas, Wisconsin, Michigan and West Virginia.

What new oil fields may yet be discovered in other parts of the world, particularly the less explored regions,

Winchester, D. E., "Oil Shale of the Uinta Basin, Northeastern Utah, and Results of Dry Distillation of Miscellaneous Shale Samples," *United States Geological Survey Bulletin*, 691, pp. 27-55, 1919.

Condit, D. D., "Oil Shale in Western Montana, Southeastern Idaho, and Adjacent Parts of Wyoming and Utah," *United States Geological Survey Bulletin*, 711, pp. 15-40, 1919.

Ashley, G. H., "Oil Resources of Black Shales of the Eastern United States," *United States Geological Survey Bulletin*, 641, pp. 311-324.

<sup>7</sup>The average production of the Scotch oil shale distilled in recent years is stated to approximate 22 gallons per ton.

no one can foretell, but it seems probable not only that oil will be distilled from the shales of the Green River group long after the principal oil fields of the world have been exhausted, but also that the total amount that may be obtained from this source may approach the world's total production of natural petroleum. The fact that some of the rich deposits of phosphate in the Permian of Idaho and southwestern Montana are accompanied by shales, which on distillation yield small amounts of oil,<sup>8</sup> suggests an interesting problem for the consideration of the chemical engineer.

How soon oil may be produced in this country by the distillation of oil shale on an industrial scale at a commercial profit, and how rapid the production may grow remains to be demonstrated. Over 40 companies are said to have been honestly organized for the production of shale oil in Colorado and Utah, and many companies have been formed for the sale of stock. The shale oil industry of this country is now in an experimental stage. A number of plants are already constructed or are building to try out different processes and conditions. Foremost among the elements to be determined are the best methods of retorting with reference to the recovery of the most valuable products, refining methods adapted to the particular shales in hand, and the possible by-products and their relative importance. Other questions to be considered concern water supplies and transportation problems; the establishment of great plants; the build-

ing of towns, and the housing, feeding, etc., of a great industrial population numbering hundreds of thousands of men. The development of a great shale oil industry is certain eventually to take place in this country, and, so far as concerns mere costs of production, it would seem that the recent advances in oil prices must bring it near to hand. Nevertheless, in view of the technological problems to be solved experimentally, it appears rather likely that shale oil will be sorely needed long before it is produced in amounts sufficient to bring appreciable relief, and much longer still before it can supply a large part of a consumption demand even no greater than that of the present day.

In view of this grave probability, the passage of the experimental stage, with its losses and waste of none too well guided capital, should be hastened by the establishment of testing plants and research laboratories by the government and by wise and foresighted investigation and tests on the part of the stronger oil companies. It is absolutely a matter of insurance of the public and country.

Oil shale industries have enjoyed a long existence in Scotland, France, and Australia, and oil from Scotch shales helped the British Navy to victory. However, it is an interesting circumstance, reflecting possibly changed conditions, that just now, when we are driven to greater efforts to establish a shale-oil industry in this country, the work of the Scotch plants, formerly running on shales of low oil yield, but of unusually valuable by-products, is being transferred to the refining of oils brought from British oil fields in the east, the labor costs being too high for

<sup>8</sup> Condit, D. D., "Oil Shale in Western Montana, Southeastern Idaho, and Adjacent Parts of Wyoming and Utah," *United States Geological Survey Bulletin*, 711, pp. 15-40, 1919.

the profitable utilization of the shale in competition with oil more cheaply produced in increasing volumes from the wells of Egypt, Persia and India.

The use of oil shale is a means of relief of qualified adequacy, the benefit of which can at best be realized but slowly and laboriously. Our oil shales are an endowment of inestimable value on which we are certain, ultimately, to depend heavily, though the time and rate of that dependence will be largely controlled by the rate of development of foreign oil fields, the growth of the world demand, and by consequent competitive prices of natural oil.

#### *Dangerous Growth of Consumption Demands*

The increase, both present and prospective, in the consumption demands for petroleum in the United States is hardly less alarming than our growing dependency on foreign petroleum supplies, for if in recent years the United States has furnished very close to 66 per cent of the world's whole output of petroleum, our oil industry is reported nevertheless to have at the same time demanded more than we produce, this demand having amounted to over 80 per cent of the world's output in 1919. To the extent of nearly 47,000,000 barrels the United States is already living beyond her income.

The gap between the oil production and consumption curves, illustrated in figure 1, has not been eliminated even in the past year of inadequate automotive production and post-war readjustment; thus, while in 1919 our domestic oil production was forced to an increase of nearly 25 million barrels (7 per cent), our net importations of foreign oil—*i.e.*, the excess of imports over

exports of crude—gained 14 million barrels (43 per cent). The oil requirements of the petroleum industry in the United States during the last year (1919) were, according to the preliminary returns, compiled by G. B. Richardson, of the United States Geological Survey, approximately 418,400,000 barrels, not including oil used on the leases, or probably nearly 421,000,000 in all.

It is stated that of about eight million motor cars, in round numbers, in the world, over 7,600,000 are in this country, which has been estimated to contain over 90 per cent of all the internal combustion engines. It is calculated also that the number of motor cars will ultimately exceed 12 million, if it is not restricted by fuel prices. Moreover, we are told in this connection that the orders in the hands of some of the large motor manufacturers are a year or more in arrears, and that internal combustion engines in vast numbers are to be made for tractors, airplane transportation services, launches, pumps, farm machinery and small power purposes throughout the country. On every hand new uses for oil are being devised and old applications multiplied. Not even the recent increase in prices of gasoline and other by-products can be seen to have caused a perceptible slackening in the rate of increase of consumption or to have curtailed plans for the more widespread and varied use of petroleum.

Not the least of the important consequences of the coal strike of last autumn has been the public apprehension of still higher coal prices, on account of which arrangements have been made or are making for the substitution of fuel oil for coal on railroads,

on ships, in shops, power houses, and even in heating plants, thus adding more millions, the sum of which cannot yet be counted, to the drain on our available oil resources. Further advances in the prices of coal cannot fail further to increase these consumption demands unless scarcity of oil from any source acts automatically as a check. The use of oil under steam boilers at an efficiency of 10 to 15 per cent in the generation of steam, when its use in the Diesel engine would give an efficiency of 25 to 30 per cent, is a criminal waste for even the present generation may well be called to account.

Between 1909 and 1918 the production of crude petroleum in the United States increased 95 per cent (see Figure 1), but the production of gasoline, as compiled by the United States Bureau of Mines, increased from around 13 million barrels to 85 million barrels, or 560 per cent, in the same period, while the number of automobiles and trucks increased 1700 per cent. The consumption of fuel oil by vessels engaged in foreign trade in 1919 was nearly double that of 1918. These examples illustrate the rapidity with which our industries, our commerce, and our standards of living have become dependent on petroleum, the third in value of our great mineral products.

#### *Dependence of United States on Foreign Oil*

As already noted, the production<sup>9</sup> of petroleum from the oil fields in the United States during 1919, according to the preliminary statement by G. B. Richardson, of the United States Geological Survey, was 377,719,000 barrels,

<sup>9</sup> Exclusive of oil consumed on leases and of producers' stocks except in California.

of which 371,579,000 barrels were delivered to refineries and other consumers in this country, leaving about 6,140,000 barrels which were added to stocks held by pipe-line, and other marketing companies. The increase of production was 6.12 per cent, while the increase in wells drilled<sup>10</sup> was 14 per cent. However, any sense of security predicated on the addition of the small amount mentioned above to the domestic oil in storage fades away when it is recognized that the oil now in storage in the United States is not enough to supply this country for four months. For several months oil has been drawn out from storage, the draught for January, 1920, being 700,000 barrels. On the other hand, the importation of crude oil into the United States from other countries (predominantly from Mexico) has increased from 37,735,641 million barrels in 1918 to 52,746,567 barrels in 1919, or 40 per cent. Deducting for approximately 5,925,587 barrels of crude oil exported to other countries, the net excess of our imports over our exports of crude oil for the year 1919 amounted to 46,820,980 barrels, as compared to 32,834,950 barrels in 1918. The significant facts are not only the large total amount of foreign oil necessary to meet our requirements, but also the amount (14 million barrels) of the increase for the year. In short, our demand for foreign oil has increased over 42 per cent during 1919, notwithstanding the temporary handicaps of both commerce and industry. Reports received for January, 1920, show a net importation for that month of 5,865,293 barrels, a rate of 52 per cent increase over 1919.

<sup>10</sup> *Oil and Gas Journal*, Tulsa, Oklahoma, January 23, 1920.

The reports of the Bureau of Foreign and Domestic Commerce<sup>11</sup> show that during the fiscal year<sup>12</sup> ending June 30, 1919, the total oil exports of the United States, including both crude and refined oils, such as fuel, gas, illuminating and lubricating oils, gasoline, light distillation products and residuum, altogether amounting to approximately 60,215,831 barrels, were about five million barrels, or 8 per cent less than during the preceding fiscal year. But for this falling off in our exportation of refining products due, in part, to post-war difficulties of industrial and financial readjustment in Europe, the actual increase in our importations must have been very nearly, if not quite as great as, the increase gained at great labor and cost, in our domestic production, and this in the face of increased prices for crude oil and oil products.

The program of the United States Shipping Board is reported to provide for an aggregate of 1,734 oil-burning merchant ships by 1922. To drive this merchant marine the board has called for 50 million barrels of fuel oil for the year 1920, and 30 million barrels for the first half of 1921. At this rate it may be anticipated that the fuel oil requirements for the last half of 1921 will be near or over 40 million barrels, and that the fleet, when completed, will require an annual supply of between 70 and 90 million barrels. This merchant marine supply, which is approximately equivalent to one-half of all the fuel oil now produced in the United States, constitutes a new burden superimposed on an already over-

loaded demand, and in its entirety or its equivalent must be drawn from foreign sources. If the requirements of our growing navy be added, the demands for oil for sea use will probably approximate 100 million barrels of fuel oil per year. The people of the United States will doubtless curtail their use to assure oil for the navy, but whether they will willingly go without oil at home on account of pride in the merchant marine, and in order that the ships under our flag may have ample supplies of oil as cheap as those obtained by rival ships in all parts of the world, seems extremely doubtful. It is interesting to note that our oil companies, including those operating in Mexico and Central America, are at present (March, 1920) dilatory in making contracts with the Shipping Board for more than a small part of the oil needed by our ships in 1920.

A British oil economist calculates<sup>13</sup> that by 1925 the petroleum requirements of the United States will exceed 500 million barrels and that at a later date America will become more and more dependent upon British supplies. Another high authority, W. C. Teagle, president of the Standard Oil Company of New Jersey, estimates<sup>14</sup> that in 1925 the requirements of the petroleum industry in this country will approximate 650 million barrels, an increase of more than 220 million barrels over the requirements of 1919. Unless conservation of oil through curtailment of use—for example, as fuel burned under steam boilers to generate steam—is forced automatically by scarcity

<sup>11</sup> *Commerce Reports*, No. 39, February 16, 1920, p. 932.

<sup>12</sup> All other figures in this paper are for calendar years.

<sup>13</sup> *Oil and Gas Journal*, Tulsa, Oklahoma, November 20, 1920.

<sup>14</sup> *Oil Trade and Drug Reporter*, New York, February 2, 1920, p. 15.

of oil and consequent prohibitive prices, or is sooner and more wisely brought about artificially by regulation, it seems probable to the writer that the demands of our oil industry will considerably exceed 600 million barrels, or possibly 650 million, as estimated by Mr. Teagle in 1925, though by that time our exportation of refined oils to some of the foreign markets will probably be reduced by competition of foreign oils nearer at hand and more cheaply produced.<sup>15</sup>

A drain of over one-half billion barrels, even if the annual demand be not further increased, would, if taken from the oil fields of the United States, probably exhaust the oil resources remaining available in the ground in fourteen years, or in sixteen years, if we assume that our recoverable oil possibly amounts to so much as eight billion barrels, which to the writer seems very improbable. It is fortunate for the country that the oil cannot so rapidly be extracted. On the other hand, it also seems to the writer quite improbable that an annual production of natural petroleum amounting to so much as 450 barrels can be won in any year from our domestic oil fields, the peak of whose production is likely to be passed by 1925.

On the whole, therefore, we must expect that, unless our consumption is checked, we shall by 1925 be dependent on foreign oil fields to the extent of 150,000,000 barrels and possibly as much as 200,000,000 of crude each year, except in so far as the situation may by that time, perhaps, be

helped to a slight extent by shale oil. Add to this probability the other greater probability that within five years—perhaps three years only—our domestic production will begin to fall off with increasing rapidity, due to the exhaustion of our reserves, and it becomes evident that, except for such relief as may come from shale oil production, America's future in oil will yearly become more and more completely dependent on supplies to be brought from foreign fields. This we cannot evade and must prepare for.

#### FOREIGN OIL RESOURCES

##### *Estimates of Recoverable Oil in Other Countries*

No estimate really worthy of the name can yet be made of the oil resources of the world. The best that can be offered is a scientific guess carefully formulated on the basis of the data now available and necessarily subject to an enormous coefficient of error. Of the important producing oil regions in other countries, only Roumania, Galicia, and the Baku and Grosny districts of Russia are so far developed as to offer criteria comparable to those of the United States for the estimation of their oil reserves. In none of the producing or prospective oil regions of other countries in which are located the great oil fields of the rest of the world have the geologic data been published, and in particular have the stratigraphy and structure been so far described by specialists in the geology of oil fields, as are the producing and prospective fields of the United States.

In many of the other countries, of which Mexico is an illustration, the detailed geological examinations, pos-

<sup>15</sup> However, the use of petroleum products in countries where they are now used to a slight extent or not at all is likely, on the whole, to greatly expand the market and strengthen it.

sibly accompanied by tests by the drill, have been confined to restricted areas, with but reconnaissance or even more indefinite data as to the remaining regions, which, on account of scattered surface indications or other criteria are believed to be oil bearing to an important degree. In some regions we have only the evidence of oil and gas seeps and pitch or asphalt deposits scattered in greater or less abundance over great areas, in which general geologic conditions, similar in essential characters to those of producing districts, are reported to prevail. In other regions, of which the near East, including Mesopotamia and Persia, offers the most striking example, a tremendous potential value is predicated with reasonable safety on the character, relative abundance, and wide-spread distribution of well-recognized surface indications of the presence of petroleum, though geological details are meager, and actual oil production—the latter in great abundance—is essentially restricted to comparatively few areas, the wells being mostly confined to a small area of testing in the upper part of the Karun River basin.

In countries like the Philippine Islands, Madagascar and Australia, the indications leave no doubt as to the presence of potential oil fields of some importance, but the geological information and developmental results where tests have been made are quite insufficient to permit an estimate deserving confidence as to the relative consequence of their oil resources. In portions of many of the countries it is possible only to base deductions as to probable oil contents upon analogies drawn after careful study of the data as to surface conditions and geologic

relations, and a comparison of these with those of other regions in which exploitation has demonstrated the extent of the oil deposits. Hence, while the oil resources of Roumania, Galicia and the Baku district, and a number of the older but relatively insignificant areas of western Europe, such as the Italian and Alsatian fields and the field in northwest Germany, can be roughly estimated, with a range of probable error in some cases as close as in the estimates of the oil in the United States, the reliability of the forecasts of the oil contents of the remaining regions ranges all the way to carefully made and conservative guesses, based on whatever information is in hand, with due consideration of the kind as well as the amount of the fundamental data. Unfortunately, some of the most important prospective oil regions of the world fall into the latter category. On account of this fact, any estimates made by any geologist of the oil resources of the world are likely to differ from those made by any other geologist, are subject to revision from time to time as more adequate information accumulates, and must not be given a weight of authority which they do not deserve.

The general distribution of the principal petroleum reserves of the world, so far as they are demonstrated by development supplemented by favorable geological data and reported surface indications of oil, has been somewhat diagrammatically represented by Mr. Eugene Stebinger, chief of the Foreign Mineral Section in the United States Geological Survey on a map here shown as Plate I. The circles, drawn in different sizes to indicate the relative importance of the estimated oil reserves of the different

regions, are centered near the centers of the actually productive or prospective oil fields, though the geographic distribution of the oil indications, as in Argentina for example, may extend through great stretches of country. No attempt is made to show all regions in which oil indications are reported, but concerning which the evidence in hand is not sufficient to prove them to be important.

To avoid the appearance of unwarranted exactness and finality, Mr. Stebinger tentatively represents his somewhat generalized conclusions as to the amounts of the oil reserves in each area by graphs in which the oil is shown in terms of relative importance or quantity, rather than in terms of barrels or metric tons. It will be noted that for a number of areas, like Bolivia, Northern Argentina and China, where little or no boring has been done at promising localities, the relative importance of the oil resources is shown by unshaded circles in contrast with shaded ones for the fields with settled production.

In the following table are given Mr. Stebinger's estimates for the regions represented by the circles on his map as grouped according to political boundaries or to natural petroleum provinces which transgress national boundaries. This table expresses, first, the relative values of these groups as compared with unit value for the United States, and, second, the corresponding quantities when unit value for the United States is seven billion barrels, the moderately liberal estimate for the petroleum of the United States. Totals are also given separately for the eastern and western hemispheres and for areas north of the equator and south of the

equator. In submitting these estimates which, through his courtesy, are here published for the first time, Mr. Stebinger calls attention to the fact that these totals suggest a surprisingly evenly balanced distribution of oil between the eastern and western hemispheres, and, as with the distribution of the world's coal reserves, a great preponderance of tonnage north of the equator.

OIL RESOURCES OF THE REGIONS REPRESENTED BY CIRCLES ON THE WORLD MAP, PLATE I, AS ESTIMATED BY EUGENE STEBINGER, OF THE UNITED STATES GEOLOGICAL SURVEY

Country or Region	Relative Value	Millions of Barrels
United States and Alaska.....	1.00	7,000
Canada.....	.14	995
Mexico.....	.65	4,525
Northern South America incl. Peru.....	.82	5,730
Southern South America, incl. Bolivia....	.51	3,550
Algeria and Egypt....	.13	925
Persia and Mesopotamia.....	.83	5,820
S. E. Russia, S. W. Siberia and the region of the Caucasus....	.83	5,830
Roumania, Galicia and western Europe....	.16	1,135
Northern Russia and Saghalien.....	.13	925
Japan and Formosa....	.18	1,235
China.....	.20	1,375
India.....	.14	995
East Indies.....	.43	3,015
Total.....	6.15	43,055
Total eastern hemisphere.....	3.03	21,255
Total western hemisphere.....	3.12	21,800
Total north of equator..	5.20	36,400
Total south of equator..	.95	6,655

As indicated in the preceding table, the natural petroleum resources of those regions of the world, for which the relative amounts are tentatively indicated by circles of different magni-



tudes on the map, are estimated at approximately 43 billions of barrels. Far as it may be from the exact amount, this total is to be regarded as conservative not only because it represents the cautious judgment of a well-trained and experienced oil and gas geologist based on the best information available at the present time, but also for the reason that the value assigned to the oil fields of the United States is conservative. It is to be expected, and it is certain that the appraisals of the different regions roughly indicated on the map will undergo radical changes as development proceeds and geological exploration is carried on in greater detail and with special reference to oil possibilities, and it is, of course, possible that the reserves may in some instances have been overestimated; but it is highly probable, on the other hand, that in many of the less civilized and geologically less known regions, the actual reserves may prove to be much, perhaps many times greater, than has been tentatively estimated.

It is to be noted that (1) no value is given on the map or in the above table for the oil resources of the regions marked by squares; (2) oil indications are known in regions not indicated on the map by any symbol, although in most such instances the geologic conditions seem to preclude reserves of great importance; and (3) finally, there are in other countries many untested regions in which the geological conditions appear to be favorable for the occurrence of oil fields, though surface indications of oil have not yet been reported, possibly due in part to insufficient exploration. In this connection it will be remembered that in

many oil fields in the United States the oil deposits are not indicated at the surface by such features as oil or gas springs, tar or asphalt deposits, etc.

It is highly probable that oil in considerable amounts will eventually be discovered in areas of northwest Canada, where only a limited commercial production has so far been obtained. Other foreign areas in North America which seem likely to make contributions, possibly of minor importance, to the world's supply, include Central America, Santo Domingo, and Lower California. In South America important new centers of production seem probable along a very extensive stretch of territory bordering the east slopes of the Andes, and, in addition, the gently flexed Paleozoic and Mesozoic areas of northeastern Brazil would seem to be possibly oil bearing. Madagascar offers much promise; and conditions favorable for developing oil fields appear to be present not only in Angola and other regions of west Africa, but possibly in east Africa also, while it is more than probable that the northern part of this great continent will finally reveal stores of oil more widespread and far greater in amount than is indicated on the map. Australia, Tasmania and New Zealand may yet disclose producing areas of value and it seems reasonable to expect new discoveries of importance in parts of India not indicated by circles. Arabia, Palestine, Armenia and Anatolia all offer thoroughly circumstantial indications.<sup>16</sup> Also it seems rather probable that oil will be produced in portions of Spain, Austria and other countries of western Europe

<sup>16</sup> See Schweer, Walther, *Die türkische-persischen Erdölvorkommen*, Abh. Hamburg. Kolonieninstituts, Vol. 40, 1919.

where, as until recently in Great Britain, its presence may have gone unsuspected. The relatively unaltered Carboniferous and Devonian basins of Russia are practically certain not merely to disclose new areas of production, but also to furnish extensive supplies of oil probably rich in lubricants, while Siberia, about which geological information is so greatly desired, and which is said to carry indications of oil deposits in Trans-Caspia, Turkistan, Kamchatka, and notably in northern Saghalien, may reasonably be expected to contain oil bearing areas in other regions of its Tertiary, Mesozoic and Paleozoic formations. China, in which kerosene is reported to be selling now at \$1.40 per gallon, has oil indications in four at least of her provinces. It appears probable that oil is present in Tertiary and Mesozoic basins, scattered from Persia and Transcaspia eastward as far, at least, as Gobi. Finally, the results of slight testing at a few points and the evidence of numerous oil seeps in a number of the Philippine Islands, as recently summarized by Warren D. Smith,<sup>17</sup> make fairly certain the presence of commercial oil deposits in these islands, which should be examined and fully tested by the United States, for, on account of their geographical positions with reference to world commerce, the oil deposits of these Islands may be found to be of particular value to the navy and merchant ships of this country.

The evidence as to the probable presence of additional oil reserves in the areas just reviewed is in most cases in-

sufficient to serve as a basis for more than the wildest forecast. However, these forecasts, or geological guesses, formulated conservatively with the probability that deficiencies will be very much more than compensated by excesses, lead me to conclude that there are probably 20 billion barrels of oil available in the world in addition to the 43 billion barrels contained in the regions covered by Mr. Stebinger's estimates quoted above, or as much in round numbers, as 60 billions of barrels in all. Mr. Stebinger's estimate of the oil in the regions indicated by circles may be roughly distinguished as oil in sight; that of 60 billions as total recoverable oil. This estimate of the world's total recoverable petroleum resources, in which Mr. Stebinger concurs, may differ very widely from estimates by other geologists, but we regard it as fairly conservative. It will, we believe, fall considerably within the ultimate recovery of natural petroleum now remaining in the world's underground storage.

Strongly in contrast with the oil reserves (oil in sight) of the principal known regions as indicated on the map, Plate I, is the relative rate of annual draft on these fields to supply the world's uses, which in Plate II is shown in blocks definite in scale and based on the production records. A glance of comparison at these maps shows cause for alarm that can only increase when the situation is considered more in detail.

The production of oil in the United States during 1919 approximated 378 million barrels, while our consumption requirements called for the addition of 47 million barrels of foreign oil in excess of the amount of crude petroleum

<sup>17</sup> Smith, Warren Du Pré, *Petroleum in the Philippines*, Transactions American Institute of Mining and Metallurgical Engineers, Advance Publication, February, 1920.

exported by us to other countries, the total net requirements of the American oil industry for the year being over 418 million barrels. It has been noted also that, barring financial disaster or further oil shortage and consequent prices markedly restrictive of consumption, the annual petroleum requirements of

at the present rate, to the last barrel.

Contrast this situation and its disheartening prospect with the situation of the rest of the world. A review of the accompanying table of world petroleum production, compiled by G. B. Richardson of the United States Geological Survey, shows that

WORLD'S PRODUCTION OF CRUDE PETROLEUM IN 1918 AND SINCE 1857, BY COUNTRIES  
*Compiled by G. B. Richardson, United States Geological Survey*

Country	Production, 1918			Total Production, 1857-1918		
	Barrels of 42 Gallons	Metric Tons	Per Cent of Total	Barrels of 42 Gallons	Metric Tons	Per Cent of total
United States.....	355,927,716	47,457,029	69.15	4,608,571,719	614,476,230	61.42
Mexico.....	63,828,327	9,506,289	12.40	285,182,489	42,564,549	3.80
Russia.....	40,456,182	5,520,066	7.86	1,873,039,199	247,856,218	24.96
Dutch East Indies <sup>a</sup> ..	13,284,936	1,836,914	2.58	188,388,513	25,465,114	2.51
Roumania.....	8,730,235	1,214,219	1.70	151,408,411	21,058,193	2.02
India.....	<sup>b</sup> 8,000,000	1,066,667	1.55	106,162,365	14,154,982	1.41
Persia.....	7,200,000	<sup>b</sup> 1,000,000	1.40	14,056,063	2,952,231	.19
Galicia.....	5,591,620	777,640	1.09	154,051,273	21,424,303	2.05
Peru.....	<sup>c</sup> 2,536,102	338,147	.49	24,414,387	3,255,251	.33
Japan and Formosa..	2,449,069	326,543	.48	38,498,247	5,133,100	.51
Trinidad.....	2,082,068	289,578	.40	7,432,391	1,033,712	.10
Egypt.....	2,079,750	277,300	.40	4,848,436	646,458	.07
Argentina.....	1,321,315	192,612	.26	4,296,093	617,176	.06
Germany.....	711,260	<sup>b</sup> 100,000	.14	16,664,121	2,254,974	.22
Canada.....	304,741	40,632	.06	24,425,770	3,256,769	.33
Venezuela.....	190,080	26,400	.04	317,823	44,142	.02
Italy.....	35,953	<sup>b</sup> 5,000		973,671	138,588	
Cuba.....				19,167	2,662	
Other countries.....				397,000	55,139	
	514,729,354	69,975,036	100.00	7,503,147,138	1,006,389,791	100.00

<sup>a</sup> Includes British Borneo.  
<sup>b</sup> Estimated.  
<sup>c</sup> Estimated in part.

the United States are likely, by 1925, to exceed 600 million barrels. It has also been pointed out that our domestic production which may not go over 425 million barrels a year—and is not likely ever to exceed 450 millions of barrels—would exhaust the estimated seven billion barrels of natural petroleum remaining available in the ground in the United States in eighteen years if the reserves could be drained continuously,

over 60 per cent of the oil produced in the world since 1857 has been drawn from the stores of the United States, and that in 1918, 69 per cent of the world's oil supply came from our reserves. The collective consumption requirements of all countries outside of the United States<sup>18</sup> appear at the pres-

<sup>18</sup> The net importation of petroleum by the United States may here be regarded as nearly balanced by the exports of refined oils, fuel oils,

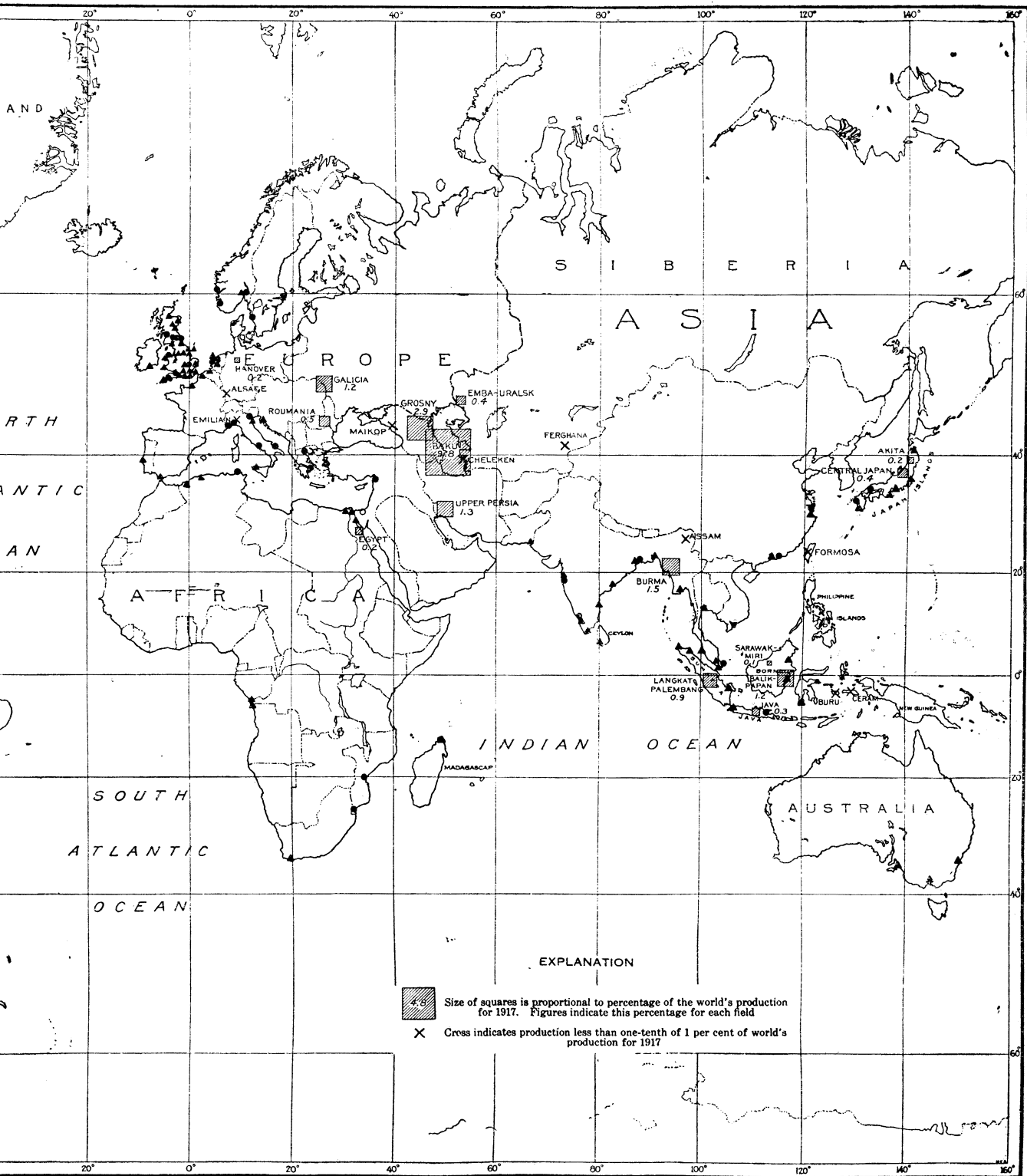


MAP OF THE WORLD SHOWING PRODUCTION

PREPARED BY THE U. S. GEOLOGICAL SURVEY

1919

Compiled by Eugene Stebbins



# ING PRODUCTION OF PETROLEUM FOR 1917

BY THE U. S. GEOLOGICAL SURVEY

1919

led by Eugene Stebinger

ent moment to impose a drain on the oil resources of the rest of the world (outside of the United States) a little less than one-half as large as the annual draft on the oil fields of our own country, or, in round numbers, about 180 million barrels annually. Therefore, if this rate of annual drain on the oil reserves of the rest of the world be similarly maintained to the exhaustion of the last barrel, the reserves of foreign "oil in sight," *i.e.*, 36 billion barrels, should last 200 years, while, the total reserves of 53 billion barrels<sup>19</sup> in the rest of the world should suffice for nearly 300 years. Oil for the United States for eighteen years, at the present rate, and oil for the rest of the world for 300 years!

#### *Peril of the United States*

It is possible that under the current unprecedented stimulus our domestic production of natural petroleum may be brought up to what the writer considers an improbable maximum of 450 million barrels per annum within the next three years, if ever, but it seems very doubtful whether the oil fields of this country can be goaded to a yield greater than that. Much depends on whether lucky strikes are bunched or irregularly scattered through a long interval. It has been shown not only that such a rate of production would probably exhaust our oil fields in about sixteen years but also, on the other hand, that the turn soon must come when our production will begin to sag and decline. Already the American

petroleum industry has outgrown the capacity of our oil fields and even now it is to the extent of over 50 million barrels<sup>20</sup> yearly dependent upon oil from foreign sources. This amount is included in the 180 million barrels drawn against the deposits of other countries. What then shall we do, when to our present overdraught must be added the millions by the hundred additional that will be required not only to meet the prospective growth of our rapidly increasing demands for oil for automobiles, trucks, tractors, airplanes, more railways, power plants, vast new machinery, the navy and the merchant marine, but also, later, to replace a waning domestic production?

The growing American consumption of petroleum, which at present seems almost irrepressible, may constitute one of the greatest menaces to the future prosperity of the United States and to its later equality of competition with the rest of the world. In America the use of oil for all purposes for which it is more convenient, or more economical, is practically unbridled. We have not only made its higher uses raise the standards of civilization, but, without thought of the future, we have unrestrainedly degraded it to its grossest and most wasteful employment. We have developed the most extravagant habits, which in time are becoming necessities, until our oil industries now require over 80 per cent of the world's output. With one-eighth as much oil in the ground as has the rest of the world, we are calling for four times as much as all other countries together. The total oil resources of Galicia esti-

---

lubricants and residuum to other countries. See *Commerce Reports*, No. 39, February 16, 1920, page 932.

<sup>19</sup> Total world's recoverable petroleum less that of the United States.

<sup>20</sup> Net imports for January, 1920, were at the rate of 70,383,000 barrels per annum.

mated by a European engineer at 47,000,000 tons<sup>21</sup> would not meet the requirements of the United States for a single year. If all available oil in the world be 60 billion barrels, as above estimated, and this were to be reserved for the exclusive use of the United States, it would satisfy our 1919 rate of consumption demands—not to mention the future—for but 140 years.

There is no substitute for petroleum except some other one or more mineral oils. Alcohol for use in internal combustion engines and vegetable oils for lubrication cannot be produced in the stupendous amounts required for present needs without destructively competing with foods and other vegetable products, which the public cannot and will not sacrifice on such magnitude of scale for the sake of building up foreign commerce or supplying our navy. This has in effect been proved by the history of the last ten years. On the other hand, as Mr. Requa has pointed out, the establishment of a shale oil production, capable of replacing the present output of natural petroleum in the United States, will require the organization of an industry with a labor complement practically equal to that of our present coal mining industry. Such a work, which has to be built up from the bottom, including transportation, the founding of cities and enormous operative works, cannot be accomplished in a few years; the labor strain alone would be too great. There will be no flowing wells in the shale regions; every ton represents individual labor and costs of mining, preparation and reduction. Oil shale is a bulkhead,

the distance to and efficiency of which cannot yet be clearly seen. Oil from any source, shale or other, must be as abundant and must be marketed as cheaply in the United States as oil is had in other countries if this country is not to be subjected to economic handicaps to its prosperity and progress.

The oil situation confronting the United States is genuinely critical and demands the most sober thought and wise but prompt action. It is time to call a halt and inquire whither we are drifting and where we shall end. Prevention of waste, restriction of employment and greater efficiency in recovery and in use will give great assistance, but all combined will not meet the situation nor solve the problem. The United States must either assure itself of sufficient oil for the future, or it must change its habits and cut down its use of oil. Curtailment, probably drastic, will in any event ultimately be forced to some extent, notwithstanding the production of oil from shale, and the public cannot too soon ask itself as to what extent the inefficient use of oil to generate steam in boilers is to be tolerated—not to say increased. On the other hand, the acquisition of sufficient reserves by our nationals should assure cheaper and more abundant oil, relieving the financial and industrial pressure to be endured as the compulsory dependence of the United States on an oil shale industry eventually becomes more widespread and complete. This country should not bear the industrial burden of advanced dependence on oil shale so long as there are ample stores of oil to be produced and brought more cheaply from some other quarter of the world.

<sup>21</sup> Commerce Reports, No. 43, p. 1042, February 20, 1920.

IMMEDIATE ACTION FOR PROTECTION  
OF THE UNITED STATES  
NECESSARY

Plainly, if the United States is to have oil to satisfy its needs in the future, it must secure adequate reserves in foreign countries, buy oil from foreign oil companies, or depend on oil shale production to fill the void. To depend on oil shale is to trust to uncertainties both as to costs and as to ultimate results, and, as has been noted, is at best to superimpose on our present social and industrial fabric an enormous and complex new industry rivalling our coal mining, salvaging but a part of our present oil industry and requiring many years for its development. Sooner or later—perhaps within a year—a commercial shale oil industry may be born in this country, but that it can originate soon enough or become large enough to offer any considerable contribution before our domestic petroleum production is already on the wane seems to the writer improbable. Shale oil production cannot be made to meet any emergency demands that may meanwhile arise. Finally, if shale oil yielding the principal and indispensable petroleum products, cannot successfully be produced and marketed as cheaply as natural petroleum from other countries, the public cannot be expected to build up and sustain a shale oil industry, unless it be under subsidy as a protective measure.

As the outlook must now be viewed, it is practically certain that after a time America will be buying oil from our commercial rivals in quantities greater by far than we have ever sold to them, to say nothing of the prices paid. But, while this may be inevitable, it surely should be escaped as far as

possible. If we are to have these oils as cheaply as they are sold in the home countries; if our industries, our transportation, our navy and our standards of living are to be safeguarded in advantages as great as those of our rivals and if our merchant ships are to get their fuel oil at prices as low as those paid by rival ships, the oil supplies needed must be in the control of our own nationals, not only now but throughout. Our prosperity and our prospects, so far as they may be affected by this important and indispensable mineral commodity which influences the daily life of every citizen, must not be subject to prejudicial regulation or discriminative restriction by any foreign power, whether ally or enemy. Only by assuring control of our nationals over the oil supplies required by this country can the protection of our future be guaranteed.

When, however, attention is given to the duty of assuring the oil reserves necessary to supply America as long as any other country enjoys an equal measure of oil adequacy we find many of the great oil regions of the world closed to us by our rivals who in many other regions have secured the lion's share or are now, with an efficiency possible only under governmental aid, ceaselessly gathering in all that is good.

On Mr. Stebinger's map are indicated roughly, (1) the regions in which American oil companies either cannot acquire concessions and produce and market the oil contents, or can do so only under restrictions making it necessary to more or less completely surrender control of the organization if not of actual operations to the nationals of some other country; and (2)



those areas in which the citizens of this country may acquire concessions in accordance with essentially open-door policies. The differentiation shown on the map is tentative, possibly erroneous, and assuredly subject to revision, with, however, immediately prospective extensions of the first class.

The situation as it existed in May, 1919, is summarized in a comprehensive and informing report submitted with recommendations by Director Van H. Manning of the United States Bureau of Mines to the Secretary of the Interior, and printed in the *Congressional Record*, for July 26, 1919 (see p. 3515). According to this report the nationals of the United States are, in general, either excluded from acquiring oil concessions in the territory, colonies, and dependencies and even in lands in the spheres of influence of Great Britain (with the exception of Canada), France, Japan, and the Netherlands, or permitted to do so only under restrictions and governmental privileges of authority that constitute either effective exclusion or loss of control and management according to the case.

It appears that aliens are excluded from prospecting for oil in Burmah, India, Persia (wholly?), Uganda (probably) and the United Kingdom; and governmental policies of exclusion of other nationals from control of oil supplies obtained in Algeria, Australia, Barbadoes, British East Africa, British Guiana, France, French West Africa, Guatemala, Japan, Formosa and Saghalien, Madagascar, Mexico (?) New Guinea, and probably in South Africa. Provision for the legal or administrative exclusion of aliens from most of these countries are already effective. Such

provisions are met also in Venezuela and Uganda.

According to reports, mineral rights cannot be transferred to aliens in Australia, Barbadoes, British East Africa, British Guiana, the Dutch East Indies, France, French West Africa, Guatemala, India (probably), Madagascar, the United Kingdom, Japan (practically), Trinidad, in part, Venezuela (qualified) and, except that now held by other nationals, in Roumania and Slovachia.<sup>22</sup> It is stated that restrictions are placed on aliens in granting oil rights or concessions temporarily in two districts of Colombia, and, conditionally, in the new territory of Roumania.

Ownership of the oil in the ground rests in the governments of Bolivia, Costa Rica, France, French West Africa, Slovachia, South Africa, Uganda, the United Kingdom, and Venezuela and, in part, in Argentina, Australia, British Guiana, Canada, Colombia, Ecuador, India and Trinidad; and movements further to vest oil rights in the state are in progress in Colombia, in Dominican Republic, Mexico, Roumania and Russia.

Whether oil lands in Mesopotamia, Palestine, the northern strip of Persia, Armenia, Arabia, Turkey and German East Africa—all marked by queries on the map, Plate I—will be open to access by our nationals after the mandates or other governmental arrangements are made for those countries remains to be seen. The present outlook does not inspire optimism.

<sup>22</sup> Domestic oil companies may not pass under foreign control in Australia, Barbadoes, British Guiana, Burmah, the Dutch East Indies, France, French West Africa, Guatemala (?) Madagascar, Trinidad, the United Kingdom, and probably in India.

Behind the curtain of secret diplomacy the rich oil reserves of the unappropriated mandatories of the near East and of the Caucasus-Trans-Caspian regions are stakes of a great game during which more than one political boundary is likely to be adjusted to meet the oil ambitions of a prospective protector, while in portions of Latin America the stresses of commercial and political diplomacy are fully exerted to the disadvantages of our nationals. Even during the long war, oil geologists in the employ of the French, the British, and the organically allied Dutch Shell interests have been examining the most remote lands including some of the unstable countries, and in certain regions have carried on their search at the very heels of the armies. According to recent British oil news the division of the Mesopotamian oil regions between the French and British has been agreed upon, and an understanding formulated in accordance with which Great Britain and her European allies will control the oil resources of the Mediterranean region.

Government participation in oil production is found in Argentina, Australia, Bohemia, Great Britain, and probably Egypt. The British government has established a petroleum administration; owns a controlling partnership with veto powers on the board of directors in the Anglo-Persian oil company, which controls the oil resources of the greater part of Persia; gives financial assistance to its nationals engaged in oil development and is in every possible way promoting the acquisition by companies under British control or companies exclusively British, of oil reserves in all countries, including our own.

As the case now stands, our nationals are either distinctly or in effect shut out of the regions containing nearly one-half of the oil in sight in the rest of the world if the open door policy is not assured in the mandatory countries. Further, if to the petroleum resources in the countries now held by Great Britain, France and the Netherlands, there be added the concessions held by their nationals in producing or prospective oil regions of other countries, the total oil resources in the control of these nations will probably exceed three-fourths of the world's oil reserves outside of the United States. An open door policy, in the mandatory countries, at least, is an economic necessity to the United States.

Such is the prospect confronting America, whose stores have to date furnished two-thirds of the world's petroleum supplies, whose growing requirements absorb over 80 per cent of the world's present production, and whose reserves are estimated to be enough to meet her present consumption rate for less than eighteen years. The increased use of the internal combustion engine, which, incidental to the great awakening following the war is already noticeable in the hitherto less progressive or even barbaric countries of the world, cannot fail to cause a great growth in the foreign demand for oil which when once under way, will gain great momentum, thus bringing augmenting pressure from all sides in the world's competition for oil. In fact, it probably is no rash prediction to forecast a world's shortage of petroleum within the next twenty years, with the likelihood that the world's supplies will be insufficient within fifteen years.

Most earnest warnings of the im-

pending danger have been issued by Director George Otis Smith,<sup>23</sup> of the United States Geological Survey; Director Manning<sup>24</sup> of the United States Bureau of Mines; Franklin K. Lane,<sup>25</sup> Secretary of the Interior, and M. L. Requa, director of the petroleum division of the late Fuel Administration. A joint memorandum by Directors Manning and Smith, and Mr. Requa will be found in the congressional record above cited.

The situation as viewed from our rival's standpoint is analyzed with unusual perspective by E. Mackay Edgar in *Sperling's Journal* for September, 1919, from which the following extracts are quoted as wholesome and profitable food for American thought:

The time . . . is coming, is, indeed, well in sight, when the United States, partly through recklessly improvident exploitation and partly through natural processes of exhaustion, will be nearing the end of some of the available stocks of raw materials on which her industrial supremacy has been largely built. . . . The processes which have practically stripped Ireland of trees are operative in the United States over a far wider territory, on a yet more appalling scale, and in connection with many other sources of national wealth. The size and magnificence of the American inheritance and the rapidity and wantonness with which it has been squandered are an almost incredible commentary on human

folly. On no country, perhaps, had "affluent Fortune emptied all her horn" in such varied and bountiful profusion, and no country could have shown itself more utterly ungrateful. The Americans have dealt with their resources, and deal with them today, in the pioneer spirit of sheer, unmitigated pillage. . . .

America has recklessly and in sixty years run through a legacy, that, properly conserved, should have lasted her for at least a century and a half. . . . But the effects of fifty years of negligence and inefficiency are now becoming visible. Just when Americans have become accustomed to use twenty times as much oil per head as is used in Great Britain; just when invention has indefinitely expanded the need for oil in industry; just when it has grown to be as common and as true a saying that "oil is King" as it was twenty years ago that steel was king; just when the point has been reached where oil controls money instead of money controlling oil—the United States finds her chief source of domestic supply beginning to dry up and a time approaching when instead of ruling the oil market of the world she will have to compete with other countries for her share of the crude product. . . .

America is running through her stores of domestic oil and is obliged to look abroad for future reserves and . . . these reserves, constituting a key position in international industry, are very largely in British hands or controlled by British capital. Before very long America will have to come to us for the petroleum she needs. . . .

The main sources of the world's supply of oil in the near future will have to be looked for outside of America. . . .

If Americans have failed to develop oil fields of their own in other lands, they will become more and more dependent upon foreign sources for the supply of one of the first necessities of twentieth century industry. Therefore, like the far-sighted men they are, they are diligently scouring the world for new oil fields—only to find, almost wherever they turn, that British enterprise has been before them and that the control of all the most promising properties is in British hands. . . .

When the industry revives in Russia and Roumania, in both of which countries the affiliated Royal Dutch companies were by far the largest producers, and when the Mexican wells are free to expand to their maximum capacity, the Shell

<sup>23</sup> Smith, George Otis, "A Foreign Oil Supply For the United States," *Transactions American Institute of Mining and Metallurgical Engineers*, February, 1920. Advance publication No. 157.

Smith, George Otis, "Where the World Gets Its Oil," *National Geographic Magazine*, February, 1920, pp. 181-202.

<sup>24</sup> Manning, Van H., "International Aspects of the Petroleum Industry," *Transactions American Institute of Mining and Metallurgical Engineers*, February, 1920. Advance publication No. 158.

<sup>25</sup> Lane, Franklin K., Annual Report of the Secretary of the Interior for the Fiscal Year June 30, 1919, p. 13. (Republished as *United States Geological Survey Bulletin* 705.)

group will be in control of not far short of a fourth of the world's supply. . . . The Shell group owns exclusive or controlling interests in every important oil field in the world—in the United States, Russia, Mexico, the Dutch East Indies, Roumania, Egypt, Venezuela, Trinidad, India (where, in conjunction with the Burmah Oil Company, it dominates the local position), Ceylon, the Malay States, North and South China, Siam, the Straits Settlements, and the Philippines. In the past few years it has been a particularly heavy investor in American Oil properties. . . .

Our true policy, therefore, while vigilantly proving and working such resources as we possess, is to encourage investment of British capital in oil, enterprises abroad, and especially in such parts of the world as are readily accessible to seapower, and to see to it by appropriate legislation that the companies so formed remain in perpetuity under British control. In one conspicuous instance, that of the Anglo-Persian Company, the government has itself acquired a majority interest in the ordinary shares; and as the company has the exclusive right to exploit for a period of sixty years from 1901 the whole of the petroleum deposits in the Persian Empire, with the exception of the five northern provinces, and as the proved territory is now definitely known to be one of extraordinary richness—the wells already sunk have a potential production of 5,000,000 tons a year—one may take it for granted that the British hold will not be relaxed. . . . With the exception of Mexico, and, to a lesser extent, Central America, the outer world is securely barricaded against an American invasion in force. There may be small isolated sallies, but there can never be a massed attack. The British position is impregnable. All the known oil fields, all the likely or probable oil fields, outside of the United States itself, are in British hands or under British management or control, or financed by British capital. We shall have to wait a few years yet before the full advantages of the situation begin to be reaped. But that the harvest will eventually be a great one can be no matter of doubt. To the tune of many million pounds a year America before very long will have to purchase from British companies, and to pay for in dollar currency, a progressively increasing proportion of the oil she cannot do without and is no longer able to furnish from her own stores. . . .

We hold in our hands, then, the secure control

of the future of the world's oil supply. We are sitting tight on what must soon become the lion's share of a raw material indispensable to every manufacturing country, intimately bound up with maritime power, and unobtainable in sufficient quantities outside of the spheres of British influence. It will be within the limits of the commanding position that the future has in store for us to hold up the entire world to ransom in the distribution and the price of this vital essential.

After making liberal deductions for patriotic vanity and bombast on the part of the British economist who, nevertheless, adduces unpleasant circumstantial data, the case as he presents it finds support to an alarming extent in the evidence already cited.

For the information of the reader, and for comparison with the estimates and forecasts by Mr. Stebinger and myself, the following is quoted from an editorial in the *Financial News* (London) of February 24, 1920:

At the commencement of the war we believed that the effective British share of the oil resources of the world was about 2 per cent. Careful admiralty calculations recently made have shown that it is now about 56 per cent. This figure includes the Persian and Burmah resources, but takes no account of the vast South American fields commanded by the British Controlled Oil-fields. The exact amount of their contribution cannot, at the moment, be estimated with anything like precision. Probably a modest estimate might put it at another 19 per cent. If that be so, our present command of the world's oil resources runs to no less than 75 per cent of their entirety.

As Secretary Lane has urgently declared, in connection with his forceful recommendations to the President and Congress,<sup>26</sup> "the situation calls for a policy prompt, determined, and looking many years ahead." This situation cannot be neglected. Longer to ignore it is to court disaster. The smug complacency that habitually blinds the

<sup>26</sup> Annual Report of the Secretary of the Interior for the year ending 1919, p. 18.

American public must be torn aside and the truth in its reality of danger faced squarely, courageously, justly, and wisely. An unprecedented crisis in our country may call for action without precedent. It is the business of the American oil companies and of

the government, working both separately and in such effective coöperation as will insure a successful outcome, to see to it that the future oil supply of America is guaranteed as fully as that of any other nation.